

Transmission System R&D Planning and Environmental Issues

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I recently read the draft consultant report prepared for the Energy Systems Integration Team of the California Energy Commission's Public Interest Energy Research (PIER) Program: "California's Electricity System of the Future Scenario Analysis in Support of Public-Interest Transmission System R&D Planning" (February 2003; P500-03-010D). While I commend the effort to analyze possible future scenarios for the California electricity system and assess transmission research and development (R&D) needs, I was dismayed with the low priority given to environmental issues. I believe a stronger case can be made for environmental issues related to transmission and, therefore, make it a higher priority for transmission R&D for PIER.

I believe the shortsightedness is due to three factors: (1) the narrow focus on public health and visibility, (2) the lack of attention to other environmental issues, and (3) the type of stakeholders that were the focus of this study. I describe in more detail these factors.

1. Narrow focus on public health and visibility

Specific environmental issues are only briefly mentioned in this report: e.g., "safe levels of electric and magnetic fields" (p. 9), "health effects of electromagnetic fields associated with high-voltage transmission" (p. 13), "public health concerns and visual impacts" of transmission lines (p. 22), and "perceived health impacts or visual concerns" (p. 25). While these specific environmental issues are important, they are only part of the story, as discussed below.

2. Need to consider other environmental issues

In May 2001, the California Energy Commission published the following PIER Staff Report: "PIER Environmental Area Research Plan: Environmental Context and Key Environmental Issues," (P600-01-014). This report contains many environmental issues that are germane to transmission system R&D planning. I have copied the relevant sections of this report for your review. I first present summaries of the key issues. This is then followed by a section on California's transmission system, and then I conclude by focusing on three high priority areas that were identified for PIER and which are relevant to the scenarios described in the transmission system R&D planning report: (1) wildlife and avian interactions with utility structures, (2) impacts of distributed energy technologies on air quality, and (3) environmental justice.

¹ The comments below are solely the author's. They do not imply CIEE endorsement of or agreement with these comments, nor that of any CIEE sponsor or the California Energy Commission.

2.1. Summary of key environmental issues in PIER report

- Wildlife and avian interactions with utility structures can result in electrocutions on poles used for distribution lines and collisions with transmission line conductors or wind turbines and supporting guy wires. Such interactions can result in negative impacts to birds, costly power outages, and violations of State and federal laws. Transmission line systems can cumulatively contribute to habitat loss and degradation, the primary factors leading to species endangerment and decreased biodiversity.
- *The Migratory Bird Treaty Act and the Bald Eagle Protection Act*. These laws have implications for the generation, transmission, distribution, and use of electricity. Migratory bird mortality by electrocution or collision with electric power distribution lines, and their deaths by collision with wind turbines (a particular problem at the Altamont Pass Wind Resource Area) can constitute a taking under these Acts. It has been estimated that approximately 750 raptors are killed each year by interaction with utility or electricity company facilities (personal communication from Dick Anderson, California Energy Commission, December 12, 2000).
- Another important issue is the invasion of exotic plants on terrestrial landscapes. The process of land conversion, in combination with increased air emissions, has transformed native ecosystems in a manner that favors the invasion of many exotic plant species. As a result, many native populations of terrestrial plant species are reduced or eliminated, resulting in subsequent declines in animal species dependent upon them. The vast network of transmission lines throughout the State, roughly 50,000 linear miles, requires extensive land conversion for construction and maintenance. When located in natural habitats, such land disturbance can promote conditions for exotic plant species. In areas with high ambient nitrogen levels, incremental additions of NO_x from power plant emissions can significantly alter ecosystems adapted to low-nitrogen levels, which can result in conditions that favor invasive species over endemic species.
- Electricity generators and the development of transmission and distribution infrastructure can increase local air emission impacts and place a disproportional burden of those impacts on local minority and low-income communities.

2.2. Transmission system [Section 2.3.2.4 in PIER report]

The network of transmission lines throughout the State, roughly 50,000 linear miles, contributes to habitat fragmentation, degradation, and incremental loss. Wildlife and avian interactions with transmission system structures can result in fatalities and interrupt power supplies. The severity of these problems increases with increased development of power delivery systems. Bird fatalities are caused by electrocution with distribution lines and collisions with transmission lines. Electrocution or collision fatalities may represent a small percentage of mortality for most species, but can significantly affect endangered and threatened species. There are particular concerns about collision- and electrocution-related fatalities of the highly endangered California condor (which has a world population of about 160), the peregrine falcon, sandhill cranes and other large water birds, neotropical migrants, and bats.

Electric and magnetic fields (EMFs) surrounding electric power lines and wires are considered by some people to potentially pose risks to human health and the environment. Human health consequences from exposure to low-level EMF, such as those under high-voltage transmission lines, are still of concern and are being debated. A working group convened by the National Institute of Environmental Health Sciences (NIEHS 1999) classified EMF as a “possible carcinogen,” based on limited evidence linking EMF to childhood leukemia and chronic lymphocytic lymphoma in adults. For other health outcomes, the working group concluded that the evidence was inadequate to either support or rule out a causal relationship to environmental EMF exposure (NIEHS 1999).

The management of transmission and distribution line right-of-ways requires consideration of vegetation management and herbicide use to minimize fire risk and maintain access. However, practices such as the planting of non-native plant species, the application of herbicides, operation of equipment, and frequent clearing can affect native habitat and aquatic and terrestrial ecosystems. Often, the services and accessibility provided by right-of-ways override environmental concerns. It is likely that management of right-of-ways will receive more attention from wildlife and water quality authorities in the next few years.

2.3. High priority issues for the PIER Program

2.3.1. Wildlife and Avian Interactions with Utility Structures [Section 3.2.2.1. in PIER report]

Issue Statement

Wildlife and avian interactions with utility structures can result in electrocutions on poles used for distribution lines and collisions with transmission line conductors or wind turbines and supporting guy wires. Such interactions can result in negative impacts to birds, costly power outages, and violations of State and federal laws. Transmission line systems can cumulatively contribute to habitat loss and degradation, the primary factors leading to species endangerment and decreased biodiversity.

Discussion

Electricity is transmitted throughout the State via hundreds of thousands of miles of distribution (generally less than 60 kilovolts) and transmission lines. Wildlife and avian interactions with these lines can be beneficial (e.g., by providing nesting and perching and migration corridors), or detrimental (e.g., by causing collisions, electrocutions, and habitat fragmentation). Such interactions will increase with heightened demand for new lines from new generation systems and land developments. Wind developments are very land-intensive and are responsible for killing an estimated 750 raptors and unknown numbers of bats and migratory birds each year. Under the current demand for more energy production in the State, wind development is anticipated to increase.

Transmission lines cumulatively contribute to habitat loss and degradation when traversing through native habitats. The need to maintain low vegetation growth and maintenance roads along these lines generally promotes the invasion of exotic species to

the detriment of native species. Although there is some thought that vegetated transmission corridors traversing disturbed habitats may facilitate wildlife migration corridors among otherwise fragmented habitats, little information is available in support of that concept. These rectangular patches of habitat have high perimeter-to-area ratios (edge effect), thereby increasing the influences of the adjacent, non-natural land uses and reducing the intrinsic value of the patch as a whole.

Collisions with, and electrocutions by, power lines can be biologically significant when they affect a population's ability to sustain or increase its numbers locally or throughout its range. Birds are electrocuted on the poles of distribution lines because designs place conductors and groundwires close enough together that wings or other body parts can touch two "hot" spots simultaneously. Raptors are disproportionately vulnerable (at risk) because of their large size and attraction to power poles; poles provide perches for hunting, resting, feeding, and territorial defense. Electrocutions are documented throughout the State, and some single poles are responsible for thousands of deaths. Moreover, electrocuted raptors and other birds cause a significant number of power outages and grass fires annually. Collisions with power lines tend to occur most frequently with the uppermost ground wire and can result in high fatalities when lines span areas with high bird use. Little is known about the extent of this impact and, therefore, its implications to avian populations. There are recent reports of significant localized mortality of large migratory water birds, including sandhill cranes and tundra swans, from collisions with power lines near wetlands. Some of the species involved are rare and local (cranes), and all have legal protection under wildlife laws and treaties.

Wind turbines and supporting guy wires can be responsible for large numbers of bird fatalities, especially to raptor species, but also to large flocks of migrating passerines. More recently, researchers are noting seasonal peaks in bat fatalities from wind farm developments, but bats have not been a specific focus of research conducted to date. In the Altamont Wind Resource Area, fatalities to golden eagles may be having a substantial affect on the local population. Additionally, large-scale wind developments are land intensive, requiring between 40–50 acres per megawatt.

Although research has been conducted to help document the problems, little is known about the statewide significance of these impacts, and solutions are still pending. Future research is needed to substantiate the theory of transmission line corridors enhancing migration, as well as the claims that these linear disturbances are significantly contributing to habitat degradation. Significant progress had been made in the last decade to understand causes of electrocution and collision risk; however, many solutions are still unproven or have proven ineffective. For example, collisions with conductors may be reduced by spacing or with marking devices designed to increase line visibility. However, intrinsic factors such as inclement weather, bird shape and behavior, and habitats affect the vulnerability to collisions. There are several designs for marking devices intended to increase line visibility. However, the efficacy of each design is not well known and needs further studies. Additionally, some devices work better for some species than others. Retrofitting, moving, or burying transmission lines to reduce collisions could be a significant economic challenge. Devices designed to insulate electrocution points on distribution lines have been developed. However, a recent study found that 37 percent of the devices installed were defective and ineffective, while 65 percent were installed improperly. Retrofitting lines to make them more bird-friendly is considered by utilities to

be highly cost prohibitive. Wind energy research has been conducted on tower type, size, numbers, and placement, and some research has focused on avian vision and hearing. More studies and standardized methodologies and protocols are needed to develop nocturnal survey methods, evaluate the relative impacts of large versus small turbines, ascertain the efficacy of risk-reducing devices, and better understand the species-specific numbers of fatalities that constitute significance.

Avian mortality studies have been sponsored by various entities, including the Energy Commission, private sector firms (including wind energy companies), EPRI, DOE, the National Renewable Energy Laboratory (NREL), Raptor Research Foundation, the Energy Commission, Edison International, and PG&E. The National Wind Coordinating Committee (NWCC) consists of a broad-based collaborative of stakeholders interested in addressing wind turbines and avian mortality. The Avian Powerline Interaction Committee (APLIC) consists mainly of utility interests and has been instrumental in providing workshops and publications that focus on electric systems tower designs to reduce collision and electrocution. Co-sponsorship opportunities with these organizations, as well as with USFWS and CDFG, are likely.

Historically, the pursuit of bird and bat mortality data at wind energy and transmission sites has been somewhat hindered by the reluctance of some power producers to share information regarding incidents of bird and bat electrocutions and collisions. Similarly power distributors are often reluctant to share information on bird electrocutions or collisions. However, the efficacy of mitigation measures is dependent on such data. USFWS has been increasingly applying pressure, through threats of shutdowns, permit violations, and steep fines, for utilities and wind developers to reduce impacts. Effective mitigation measures will enable the electricity system and wind turbine development to expand responsibly, and without violating the Migratory Bird Treaty Act, Bald Eagle Protection Act, and Endangered Species Act.

2.3.2. Impacts of Distributed Energy Technologies on Air Quality [Section 3.2.3.1. in PIER report]

Issue Statement

There is a need for improved methods, tools, and data to estimate impacts of emerging energy technologies (e.g., distributed energy) and fuels on air quality.

Discussion

Distributed energy technologies are electrical generation or storage systems located at or near load centers. Such systems are typically small (i.e., less than 50 MW) and modular. They may be located at a customer's premises on either the utility or customer side of the meter, or located at other points in the distribution system, such as a utility distribution substation. Distributed energy technologies include diesel engines, microturbines, small gas turbines, fuel cells, internal combustion engines, photovoltaics, solar dish Stirling engines, and wind, and may involve the use of combined heat and power. Configurations of distributed energy technologies include the installation of a single system or the aggregation of multiple units. Many combustion distributed energy technologies use

natural gas; however, backup generators (which are not used as primary electricity generators) mostly use diesel fuel.

As electricity demand in California grows, distributed energy technologies are often being proposed as a solution, particularly to meet short-term peaking needs. Because these technologies can be put on-line in a short time at a low cost (relative to traditional generation units), the California energy market and regulators are likely to be confronted with many proposals for distributed energy technologies in the next few years. Fossil-fueled distributed generation will add emission streams near ground level and will therefore potentially have more local impacts. Some of these impacts may be avoidable if proper precautions are taken to reduce emissions from generators (e.g., in meeting certification standards), if they are to be operated more routinely.

As a result, the need for improved methods, tools, and data to estimate the air quality impacts of these technologies represents a pressing need throughout the State. Distributed energy technologies that generate less than 50 MW fall outside the Energy Commission's power plant siting jurisdiction, and the California Public Utilities Commission is not required to issue permits for these units unless an investor-owned utility owns the facility. Therefore, permitting and approval for most distributed energy technologies has fallen to the cities, counties, and air districts (jurisdictions having little experience with permitting the newer distributed energy technologies), or has been altogether missing.

Until recently, California had not developed uniform emission standards for the permitting of distributed energy technologies, but the expected growth of these units in the State has prompted legislation to create such standards. Senate Bill 1298 (signed by the governor on September 25, 2000; 2000 Statutes, Chapter 741) requires the California Air Resources Board (CARB) to establish uniform standards for distributed energy technologies that reflect the best performance achieved in practice by the distributed energy technologies that are exempt from district permitting. Those standards must then match the BACT levels for central station power plants at the earliest practicable date. CARB is also developing permitting and certification guidance for units that fall under their jurisdiction.

Energy planners and regulators need effective methods, tools, and data to evaluate the implications of new distributed technologies on emission levels within air districts and to assess the effect of differing strategies for meeting air quality plan attainment dates (e.g., including the extended operation of standby generators during energy shortages). Other environmental impacts, such as noise pollution and waste heat, should also be investigated. Regulators will also need to evaluate environmental impacts to author rules that protect public and environmental health, as well as to determine any economic benefits that power producers might receive, such as emissions offsets. Without adequate methods, tools, and data to address the environmental impacts of distributed energy technologies, California regulators will be unable to forge sound, science-based regulations that will ensure public and environmental health—and new environmentally preferred technologies may have greater difficulty in gaining competitive market entry.

Although several research organizations are investigating the development of these technologies and promoting their commercialization, only two studies have examined the air quality impacts associated with these technologies: one sponsored by the California Air Resources Board (Iannucci et al. 2000) and another sponsored by The Energy Foundation (Lents and Allison 2000). There is clearly a need for further investigation.

Because of the substantial interest in developing, promoting, and using these technologies, the Energy Commission expects that costs could be shared with CARB, DOE, EPA, EPRI, the Gas Technology Institute (GTI), and others. The Energy Commission anticipates that solutions will most likely use existing methods and tools or adapt them from existing emissions procedures and equipment, which is likely to help ensure the success of projects addressing this issue. Once developed, these solutions should be easily implemented.

The Energy Commission predicts that better methods, tools, and data will facilitate the successful widespread introduction of distributed energy technologies in California, while ensuring that these technologies contribute to better air quality in the State.

2.3.3. Environmental Justice [Section 3.2.3.3. in PIER report]

Issue Statement

Electricity generators and the development of transmission and distribution infrastructure can increase local air emission impacts and place a disproportional burden of those impacts on local minority and low-income communities.

Discussion

California law (Senate Bill 115, (signed by the governor on October 6, 1999; 1999 Statutes, Chapter 690) defines environmental justice as "... the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies." Because of an expanding economy and population, California faces an increased demand for electricity. As a result, many new facilities will have to be built in the next few years, along with extensive energy-efficiency activities. In the context of California electricity generation, environmental justice most often becomes an issue when repowering existing facilities, or when siting new electricity generators or transmission and distribution infrastructure. The siting process addresses environmental justice issues by helping to ensure that plant siting will not disproportionately affect minority and low-income portions of the communities in which they are built.

Regulatory agencies involved in the siting process examine environmental justice issues as part of the proceedings. Thermal electricity generators with a rated capacity of 50 MW or larger are granted permits to build and operate by the California Energy Commission. Smaller-capacity generating equipment is either issued a permit by the local air district or requires no permit (depending on capacity size and projected hours of annual operation). CARB is developing a certification program and uniform emission standards for electrical generation technologies that are exempt from district permitting requirements. CARB helps to ensure that power plants are constructed in compliance with all applicable laws, ordinances, regulations, and standards.

Historically, environmental justice evaluations have addressed large central generating power plants, and have therefore been handled by the Energy Commission. However, the State is expected to experience an influx of distributed generation (DG) units (many of which have a capacity less than 50 MW) in the near term, which means that air districts may need to evaluate permits for an increased number and variety of generating units. In addition, combustion-based DG units could potentially exacerbate the problem of

increased emissions. Some combustion-based DG generators are not as clean-running as modern central generating plants, partly because emission controls are currently either unavailable or not as effective as those of state-of-the-art central power plants. Moreover, most DG units do not use tall stacks to carry emissions from the area, which increases local exposure. CARB is currently working on regulations and guidance for the approval and use of DG in the State.

Generally, an evaluation of environmental justice issues must characterize air quality in existing minority and/or low-income areas, characterize the impacts of a new power generating facility, assess the health and welfare impacts on the local population that would arise from the installation and operation of that facility, and identify potential mitigation opportunities. Siting evaluations must use unbiased scientific methods consistently, and also apply a consistent set of criteria (that is impartial to race and economic factors) to all potential sites.

Two elements are key to deciding whether to site a generator in a particular location:

1. the existing level of air toxics and criteria pollutants in the community being proposed for the site
2. sound data on potential local air toxics and criteria pollutants from a proposed generating unit

However, available data on existing concentrations of emissions (i.e., before the installation of the power facility) and techniques to predict ground-level concentrations of air emissions in the immediate vicinity of the proposed power facility are often inadequate. For example, air quality assessments should evaluate the potential site (which may not have monitoring equipment in place), rather than a nearby site where monitoring equipment might already be located.

The evaluation must also predict the emissions and dispersion pattern of the proposed generating unit at that site, which can be a complicated endeavor. CARB's Neighborhood Assessment Program Work Plan (CARB 2000b) states that "...evaluating environmental justice issues and identifying difference in impacts among communities will require determining cumulative exposures, which is a technically difficult task." It also says that "...no clear guidance exists as to how to assess air pollution impacts at the neighborhood scale."

Ideally, an environmental justice examination should review not only the level and distribution of *emissions*, but also examine the distribution of *impacts*, perform dynamic analyses that consider those factors on a neighborhood level over time, and identify potential mitigation options. At this time, the need for improved methods, tools, and data make such an examination difficult.

For power plant developers, the prospect of increased local emissions from new or repowered power plants can bring about public opposition, which can slow or stop the development of new facilities. Without accurate data that are mutually acceptable between both the community and developers, siting discussions can grind to a halt. Addressing environmental justice concerns from the outset of the review process will facilitate the approval of suitable sites and mitigation strategies. There may be some reasons why

certain areas, such as decommissioned military bases or brownfields, are a good site for power plant and transmission development.

Sound data on potential local emissions from a proposed power plant is a key element in the decision of whether or not to site the plant in a particular location. It also provides all the stakeholders with a picture of the magnitude of the potential facility's impact on the community. Given the pressing need for additional electricity in the State, the time for licensing new power plants has been reduced. A rapid review process will require a streamlined method for judging the appropriateness of a site, in regards to environmental justice, and accurate data for evaluation by all stakeholders.

Environmental justice issues associated with electric power plants in California have not been addressed by other R&D institutions, although related activities in California have been undertaken. CalEPA has a Working Group on Environmental Justice that is developing an interagency environmental justice strategy. CARB is examining environmental justice issues, but primarily through in-house analysis. It has a Community Health Program that addresses community air quality issues through a Neighborhood Assessment Program, Community-Based Air Toxics Evaluations, a Children's Environmental Health program, and an Indoor and Personal Exposure program. The Community Health Program's primary focus is to develop assessment tools and explore long-term policy options for addressing environmental justice issues. The Governor's Office of Planning and Research has an environmental justice steering committee that works with other agencies to coordinate policy around environmental justice issues, including environmental justice training. The South Coast Air Quality Management District and the Bay Area Air Quality Management District examine environmental justice issues in their respective regions. The EPA has environmental justice projects across the United States: currently, the only one in California is at Barrio Logan, near San Diego.

Work addressing environmental justice issues would involve a number of technologies and benefit a wide variety of stakeholders, so it seems likely that costs could be shared among many technology developers, researchers, and governments. As power plants become more difficult to site, being able to conduct accurate site-specific analyses will become crucial, saving time and money for all of the stakeholders involved, and helping to ensure the public health.

3. Need to Broaden List of Stakeholders

The stakeholders mentioned in the consultants' report are very important, however, several key environmental organizations were not included. As an example, I have listed below the following organizations that were members of the Stakeholder Review Group for the PIER report referenced above. Many of these organizations would undoubtedly be interested in the environmental issues associated with transmission R&D planning.

Association of California Water Agencies
Biomass Energy Alliance
California Air Resources Board
California Department of Fish and Game
California Department of Water Resources
California Environmental Protection Agency
California Farm Bureau
California Independent System Operator
California Manufacturers and Technologies Association
California Resources Agency
California Solar Energy Industries Association
California Wind Energy Association
Center for Energy Efficiency and Renewable Technologies
Environmental Defense
Geothermal Energy Association
Green Mountain Energy
Independent Energy Producers
Natural Resources Defense Council
Pacific Gas and Electric Company
Pacific Institute for Studies in Development, Environment, and Security
Resource Catalysts
Sacramento Municipal Utility District
Silicon Valley Manufacturing Group
Southern California Edison Company
Southern California Gas Company
State Water Resources Control Board
Union of Concerned Scientists
U.S. Environmental Protection Agency (Region IX)
U.S. Fish & Wildlife Service

In conclusion, I hope the Energy Systems Integration Team and its consultants revise the consultant report by incorporating, at a minimum, the following features: (1) a broader array of environmental issues, and (2) the inclusion of more environmental organizations to their list of stakeholders. I would expect that environmental issues would become a higher priority transmission R&D planning issue.

If you have any questions, please contact me at 510-486-6047, or via email at Edward.Vine@ucop.edu.